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Biston rosenbaueri sp. n. (Lepidoptera, Geometridae, Ennominae) from the Balkan Peninsula

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Abstract. A new species of *Biston* from the Balkan Peninsula is described. This species, *Biston rosenbaueri* **sp. n.**, has been previously overlooked for a long time. The species is nearest to *Biston strataria* (Hufnagel, 1767) and also close to *B. achyra* Wehrli, 1936. Male genitalia and barcoding data are compared for these externially similar species from the Western Palaearctic.

Zusammenfassung. Nahestehend den Arten *Biston strataria* (Hufnagel, 1767) and *B. achyra* Wehrli, 1936 wird eine dritte bisher übersehene Art, *Biston rosenbaueri* **sp. n.**, vom Balkan beschrieben. Die männlichen Genitalien und die Barcodedaten werden mit denen der bisher bekannten ähnlichen westpaläarktischen Arten verglichen.

Introduction

The genus *Biston* contains more than 50 species (Scoble and Hausmann 2007). Their distribution area covers the Holarctic and Oriental regions as well as Africa. All species are large and robust, with a wingspan between 30–80 mm, and with females often larger than males. The abdomen, thorax and tegulae are covered in a dense vestiture of scales giving a furry-appearance. The antennae are bipectinate in males, while filiform in females. On the forewing venation, Sc is free, whereas R1 and R2 are usually stalked. R2 is sometimes connected with R3–R4 or R3–R5 by a transverse bar. R3–R5 is not stalked with M1. On the hindwing Sc + R1 is close to the cell, while M1 runs from the anterior angle of the cell, but M2 and A3 are absent. CuA1 forks off before or from the posterior angle of cell (Jiang et al. 2011).

In Europe (Müller 1996) and other parts of the Western Palaearctic, two similar *Biston* species are known so far, namely the widespread *B. strataria* (Hufnagel, 1767) and *B. achyra* Wehrli, 1936 described from eastern Turkey but known from the Caucasus, Transcaucasus and Turkmenistan (Viidalepp 1996). Beshkov (2017) reported the occurrence of *B. achyra* from Bulgaria, figuring the adult moths as well as male genitalia. DNA barcodes from this Bulgarian material was left as a task for the future. Both species have also been reported from the Greek island of Samos (Fritsch et al. 2014).

These moths are on wing in early Spring, when undoubtedly the dense thoracic scaling aids in thermoregulation.

Recently, Frank Rosenbauer and Peder Skou collected male *Biston* specimens in Greece, while Egbert Friedrich collected similar specimens in north-western Croatia. Examination of this material reveals the presence of a third, hitherto unknown species morphologically similar to *B. strataria*

and *B. achyra*. The results of DNA barcoding confirm the separation of this third species. In this article, this new species is described and its morphological characters are illustrated. Further investigations are needed to clarify whether the Bulgarian specimens (or some of them) belong to this new species.

Materials and methods

The publication is based on material obtained from the following institutional and private collections:

Acronyms

EFJ	Private collection of Egbert Friedrich, Jena, Germany
BMB	Private collection of Bernd Müller, Berlin, Germany
DFL	Private collection of Dieter Fritsch, Lörrach, Germany
FRM	Private collection of Frank Rosenbauer, Münster, Germany
PSS	Private collection of Peder Skou, Vester Skerninge, Denmark
MNHU	Museum für Naturkunde, Berlin
SMNS	Staatliches Museum für Naturkunde, Stuttgart, Germany
ZSM	Zoologische Staatssammlung, München, Germany

Morphological studies

For genitalia preparations, a standard procedure (Robinson 1976) was followed. Genitalia dissections were made using a stereo microscope CARL ZEISS JENA SM XX. After maceration, the genitalia preparations were stained with Chlorazol Black and embedded in Euparal. Genitalia slides were photographed using a Leica Z16APO digital stereo-microscope equipped with a DFC 49 camera in SMNS by Hossein Rajaei. Adult specimens (except for Fig. 2) were photographed using a Panasonic DMC-FZ50 digital camera with Leitz ELPRO 1 and two close-up lenses.

Examined comparative material

Biston strataria: 1 ♂, [Germany], Berlin-Rosenthal, 09.iii.[19]66, e.l., B. Müller [leg.], gen. prep. 546 B. Müller, coll. BMB; 1 ♂, Germany, Mark Brandenburg, Dannenreich bei Königs Wusterhausen, 15.iv.1984, leg. J. Gelbrecht, gen. prep. 492 B. Müller, coll. BMB; 1 ♂, Germany, Mark Brandenburg, Dannenreich bei Königs Wusterhausen, 12.iv.1980, leg. J. Gelbrecht, coll.BMB; 1 ♂, Nord-Tunesien, Prov. Jendouba, Kroumirie, 630 m, südl. Ain Draham, 36°45'N, 08°40'E, 20.iv.2006 at light, leg. Henri Hoppe, gen. prep. 549 B. Müller, coll. BMB; 1 ♂, Greece, Epirus, Umg. Joannina/Zagoria, Papigo, 900 m a.s.l., e.l. 26.v.2002/17.ii.2003, E. Friedrich [leg.], gen. prep. 1031 B. Müller, coll. EFJ; 1 ♂, Greece, Thrace, Avantas, 200 m a.s.l., 40°57'38.02"N, 25°54'58.55"E, 1–3.iv.2013, leg. Frank Rosenbauer, gen. prep. 1034 B. Müller, coll. FRM; 3 ♂♂, Greece, Samos, Stavrinides, 1.iv. 2011 (2 ♂♂), 3.iv.2012 (1 ♂), leg. Dieter Fritsch, gen. prep. 1037/1038/1040 B. Müller, coll. DFL. 1 ♂, Germania septentrionalis, Land Brandenburg, Landkreis Havelland, Paulinenaue, NSG Lindholz, 12. März 2007, legit Bernd Müller, coll. BMB; 1 ♂, Hispania, Castilia, Sagoria, S. Ildifonso, 1100–1300 m, 1910, [leg. unknown], coll. MNHU.♂

Biston achyra: 2 ♂♂, Israel, nr. Haifa, Nahal Oren, 28.iii.2000, leg. Li/Müller, gen. prep. 1029 (1 ♂), coll. PSS. 1 ♂, Greece, Samos, Kokkari, 9.iii.2010, leg. Bech et al., gen. prep. 1035 B. Müller, coll. DFL. 1 ♂, Greece, Samos, Vourliotes, 18.iii.2015, leg. Bech et al., gen. prep.1036 B. Müller, coll. DFL. 1 ♂, Greece,

Samos, Manolates, 3.iv.2012, leg. Bech et al., gen. prep.1039 B. Müller, coll. DFL. 1 ♂ Greece, Samos, 1.7 km WSW Kokkari, 9.iii.2010, leg. Bech et al., coll. ZSM.

DNA barcoding

After sending legs for extraction to Guelph, a 658bp fragment ("DNA barcode") of the mitochondrial COI gene was amplified and sequenced at the Canadian Centre for DNA barcoding (CCDB, Guelph), in the framework of the Lepidoptera Campaign of the international Barcode of Life programme (iBOL). Altogether, barcode data from 72 *Biston* species were used.

Description

Biston rosenbaueri sp. n.

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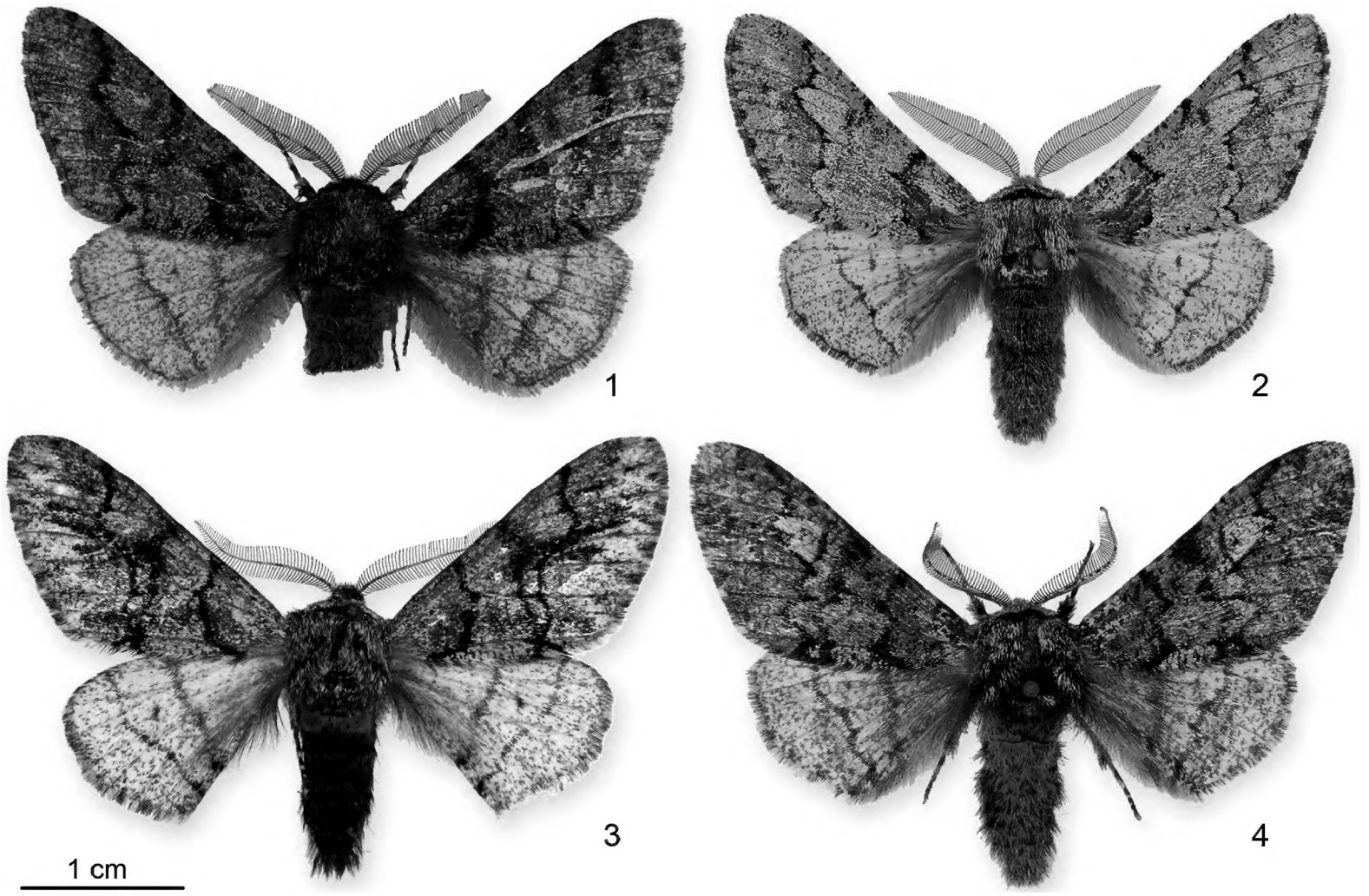
Figs 1, 2, 5, 6.

Type material. Holotype ♂, Ost-Griechenland [Eastern Greece], Thrakien [Thrace], Avantas, 29.ii.-01.iii.2016, leg. F. Rosenbauer, gen. prep. 1033 B. Müller, deposited in coll. ZSM; **Paratypes:**1 ♂, same data as holotype, not dissected, coll. FRM; 1 ♂, Kroatien [Croatia], Insel Krk, 4 km östl. Punat, 300 m a.s.l., 27.iii.2005 at light, E. Friedrich [leg.], gen. prep. 1030 B. Müller, coll. EFJ; 1 ♂, Kroatien [Croatia], Insel Krk, 3 km s/w, Vrbnik, 200 m a.s.l., 26.iii.2005 at light, E. Friedrich [leg.], gen. prep. 1032 B. Müller, coll. EFJ.2 ♂♂ Kroatien [Croatia], Insel Krk, 3 km s/w, Vrbnik, 200 m a.s.l., 26.iii.2005 at light, E. Friedrich [leg.], coll. EFJ, not dissected, 1 ♂ Greece, Florini, Kristalopigi, 1000 m, 17.iv.1987, Peder Skou leg., gen. prep. 015 Peder Skou, coll. PSS.

Adult male (Figs 1,2).Wingspan 40–45 mm. Abdomen, thorax, tegulae very hairy. Forewing: Ground colour white, densely suffused with light and dark brown, sometimes also black scales, together giving a pale grey or brownish impression. Veins brown or black. Postmedial and antemedial line distinct, black, on veins thickened, forming small triangles pointing towards the wing base. Postmedial line undulating, angled on vein M3 and M2. Antemedian line bent, sharp or more diffuse, sometimes angled on M3 and A. Medial line indistinct. Postmedial line on outer margin, antemedial line on inner margin with a broad pale brown band, in darker specimens indistinct. Terminal area with a diffuse whitish line, sometimes absent. Discal spot distinct, slightly blurry. It lies between the postmedial and the medial line. Hindwing less suffused with dark scales, therefore paler than the forewing. Its postmedial line nearly straight, its medial line diffuse, straight. Discal spot present as a distinct dot. Both wings with fringes weakly chequered brownish and grey. Labial palpi also very hairy, medium brown, frons rough-scaled, whitish. Patagia anteriorly whitish, posteriorly black. Tegulae whitish, irrorated with more or less black scales. Thorax greyish-brown as for tegulae. Abdomen beige and grey scaled. Antennae of males bipectinate with noticeable reddish-brown ciliated processes and variegated shaft. Hindtibia with 2 + 2 spurs. Female unknown.

Male genitalia (Figs 5, 6). Uncus triangular, lateral weakly setose, wide at base, about four fifths as long as the basal width. Lateral margins slightly convex, apex bilobed with a small apical hollow. Gnathos arms fused ventrally, folded, their lateral margins serrate. Juxta long, triangular, tapers evenly or slightly concave, apex pointed, somewhat bent. Valva broad, simple, membranous, approximately the same width basally and apically. Apex round, setose. Valva setose from centre



Figures 1–4. Male imagines of *Biston* species (wingspan 40–45 mm). **1**. *B. rosenbaueri* sp. n., Holotype (Greece, Thrace, Avantas, coll. Rosenbauer). **2**. *B. rosenbaueri* sp. n. Paratype (Croatia, Krk Island, coll. and photo EFJ). **3**. *B. achyra* Wehrli, 1936 (Greece, Samos, Kokkari, coll. ZSM). **4**. *B. strataria* (Hufnagel, 1767) (Germany, Mark Brandenburg, Dannenreich, coll. BMB).

to apex. Costa slightly concave, sacculus nearly straight. Saccus wide, rounded, medially short, often bent trapezoid projection. Aedeagus narrow, slightly bent, apically 1.35–1.55 mm striated, no cornutus. Length of aedeagus: 3.05–3.2 (on average 3.0) mm.

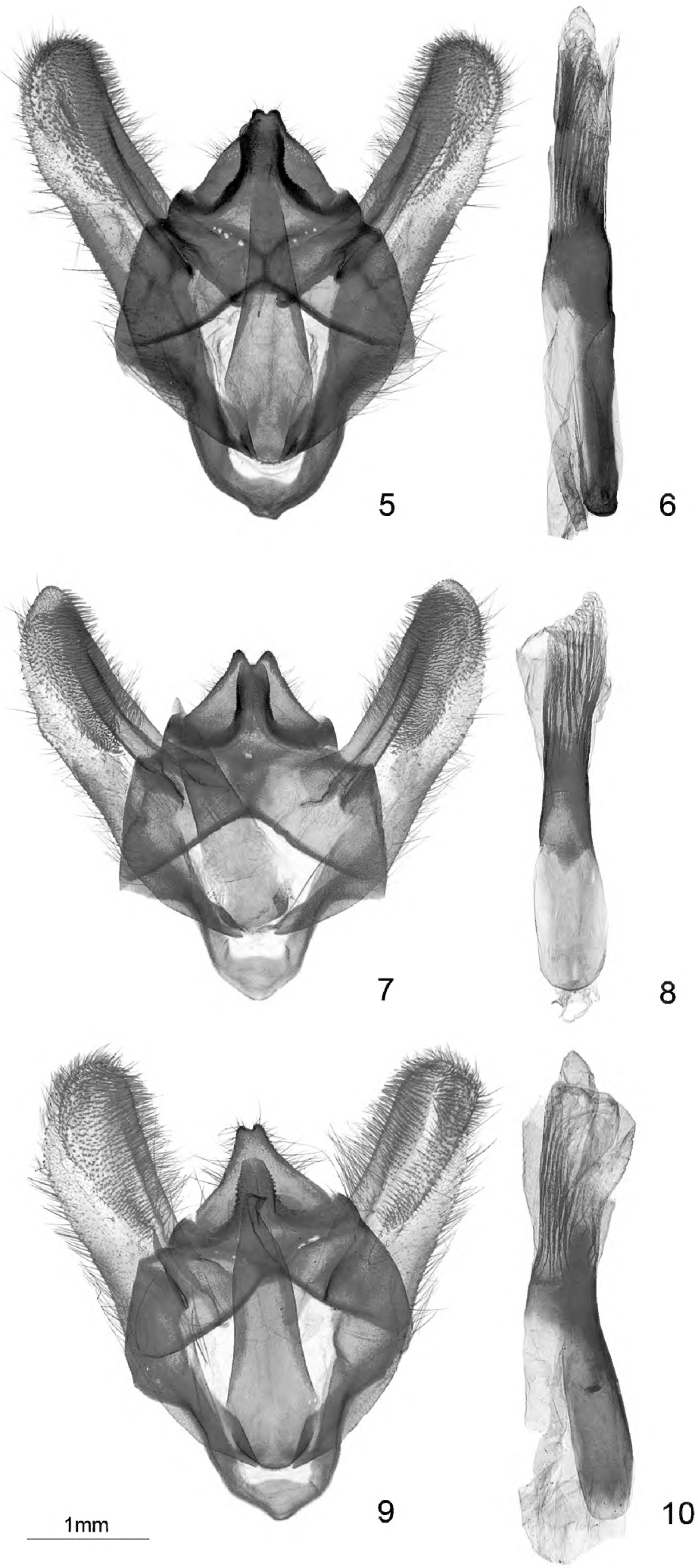
Differential diagnosis. The new species is very similar to its relatives *Biston strataria* (Hufnagel, 1767) (Fig. 4) and *B. achyra* Wehrli, 1936 (Fig. 3). *Biston rosenbaueri* sp. n. males can be separated from *B. strataria* by the distinct discal spot on hindwings, which is absent or hardly visible in *B. strataria*. *B. achyra* has on average less contrasting wing pattern, its tegulae and thorax are brownish grey and have no white blotches as can mostly be seen in *B. rosenbaueri* sp. n. and *B. strataria*. This species has also a distinct discal spot on hindwings. See Figs 1–4. In comparison with *B. strataria*, *B. rosenbaueri* sp. n. on forewing has postmedial line between the veins CuA2 and A2+A3 less ex-curved, oval, not somewhat conic tongue-like as it is in *B. strataria*; but more prominent than in *B. achyra*. Antemedial line in *B. rosenbaueri* sp. n. also looks less extended along the A2+A3 than in *B. strataria*, but similar to that in *B. achyra*. For differences in male genitalia, see Table 1.

Distribution. *Biston rosenbaueri* sp. n. is known from northern Croatia and northern Greece. The specimens have been collected at elevations between 200 and 1000 m.

Biology. Unknown

Etymology. The new species is named after the German lepidopterologist Frank Rosenbauer who collected male specimens of the new species in Greece.

Genetic data. Contributed by Axel Hausmann, ZSM.



Figures 5–10. Male genitalia of *Biston* species. **5–6**. *B. rosenbaueri* sp. n., Paratype (Croatia, Krk Island, coll. EFJ, prep. BMB no. 1032). **7–8**. *B. achyra* Wehrli, 1936, (Greece, Samos, coll. DFL, prep. BMB no. 1036. **9–10**. *B. strataria* (Hufnagel, 1767), (Germany, Berlin-Rosenthal, coll BMB, prep.BMB no. 546.

Table 1. Differential characters in the male genitalia of *B. strataria*, *B. rosenbaueri* sp. n. and *B. achyra*.

Structure	Character	Character state *B. strataria* (Figs 9, 10), N=8	*B. rosenbaueri* sp.n. (Figs 5, 6), N=3	*B. achyra* (Figs 7, 8), N=4
Juxta	apex	beak-like, with prominent thorn-like extension ventrally	slightly bent, with short rib ventrally	slightly bent, not ribbed ventrally
	lateral margins	posterior half convex, anterior half concave	nearly straight or slightly concave	nearly straight
	basis width, mm	0.5 to 0.63	0.5 to 0.6	0.4 to 0.5
Uncus	laterally	concave	convex	concave
	incision between the processes on apex	shallow	shallow	deep
Saccus	anteriorly	medially with short, trapezoid projection	medially with short, trapezoid projection	usually rounded
Aedeagus	total length, mm	2.77 to 3.14	3.05 to 3.2	2.56 to 2.69
	length of striated part, mm	1.23 to 1.45	1.35 to 1.56	0.96 to 1.11

Biston strataria (Hufnagel, 1767): BIN: BOLD:AAB4693 (n=59 from Finland, United Kingdom, Netherlands, Germany, Austria, Switzerland, France, Spain, Italy, Greece including Crete, Morocco, Tunisia, north-eastern Turkey, Russia (Urals) and Turkmenya). Genetically homogenous, but North African populations slightly diverging (0.6%), one barcoded specimen from Turkmenya diverging by 1.0%. Nearest species: *B. achyra* from Israel (3.3%).

Biston rosenbaueri sp. n.:BIN: BOLD:ADA6153 (n=7 from Croatia: Island Krk, Gorski Kotar, Greece: Epirus). Genetically homogenous. Nearest species: *B. achyra* (4.1%).

Biston achyra Wehrli, 1936: BIN: BOLD:ABZ6431 (n=7 from Greece (Samos), Turkey, Israel, Lebanon). Genetically heterogenous, Israeli populations diverging from populations from Samos and southern Turkey by 2.2%. Nearest species: *B. rosenbaueri* sp. n. (4.1%).

Discussion

It was rather surprising to find a new large *Biston* species in the Balkan Peninsula. Future work will focus on the study of the overall distribution and biology of the new species. The description of the hitherto unknown female could improve the morphological differentiation to the known species *Biston strataria* and *B. achyra*.

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